Preliminary Investigation

Caltrans Division of Research, Innovation and System Information

Review of Prefabricated Wash Rack Systems

Requested by

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Caltrans Office of Maintenance Storm Water Environmental Compliance

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Executive Summary

Background

The California Department of Transportation (Caltrans) maintains a large fleet of vehicles and support equipment needed to conduct a wide range of highway maintenance functions, including sweepers, dump trucks, plow trucks, mowers, loaders, etc. The cleaning of these vehicles and equipment is an integral part of every Caltrans operation; it benefits workers' safety and prolongs the effective life of vehicles and equipment. Caltrans Storm Water Quality handbook section C.15.1[1] states that all vehicle and equipment rinsing and/or washing shall occur only at designated, contained areas, such that all generated effluents are collected and treated before being discharged or reused. The cleaning effluents generated at highway maintenance stations (HMS) often contain sediments and trace residues of oil, salts, grease, and metals, as well as any degreasing solvents, cleaning solutions, or detergents used in the cleaning process. The Environmental Protection Agency (EPA) considers equipment wash water to be a non-storm water discharge (i.e. illicit discharge); therefore, permits from wastewater authorities are required. These permits mandate how wash water effluents are to be contained, tested, and potentially pre-treated, which includes oil/water separation before discharge into a Publicly-Operated Treatment Works (POTW), leach field, or Municipal Separate Storm Sewer System (MS4).

Caltrans has adopted storm water Best Management Practices (BMP) procedures and practices which include, but are not limited to, eliminating discharges to storm drain systems by infiltrating the wash water and training employees in proper cleaning procedures. Collected wastewater is treated to ensure that it is suitable for discharge or transfer to an off-site waste disposal facility, or filtered with in-place equipment for reuse (closed-loop). Most Caltrans HMS facilities contain some type of vehicle wash containment area commonly referred to as a "wash rack". There are many different styles of wash racks in use at Caltrans maintenance stations and equipment shops throughout the state, but generally they consist of uncovered, in-ground concrete containment pads sloped at a downward angle toward a collection sump. The containment slab is typically bordered with containment curbs consisting of a minor contiguous asphalt berm to reduce storm water run-on. Many of these wash racks have been in service for many years and will inevitability need to be retrofitted with improvements or replaced altogether to comply with ever-evolving environmental regulations and BMPs.

This preliminary investigation seeks to identify information and sources concerning the use of commercially available, prefabricated wash rack systems and their applications to highway agency operations. This report is intended to facilitate Caltrans in their wash rack upgrade efforts by providing introductory information on replacement possibilities. If additional information is needed, this PI will form the basis of an in-depth study to evaluate the feasibility, effectiveness, and life cycle cost benefits of Caltrans utilizing prefabricated wash rack systems in HMS facilities versus the current standard of permanent, in-ground concrete containment pad wash rack systems.

Prefabricated wash rack systems offer Caltrans an added option of deploying a provisional moveable system for near-term mitigation of environmental concerns. The systems could be used while Caltrans evaluates conventional long-term or permanent solutions. Caltrans also wants to understand what other governmental agencies and large private industries are doing to

[1] Caltrans Storm Water Quality Handbook, Maintenance Staff Guide, CTSW-RT-057 Section C.15.1, Vehicle and Equipment Cleaning, 2003

replace their wash racks at their facilities in order to meet environmental regulations and operational needs while minimizing wash rack lifecycle costs.

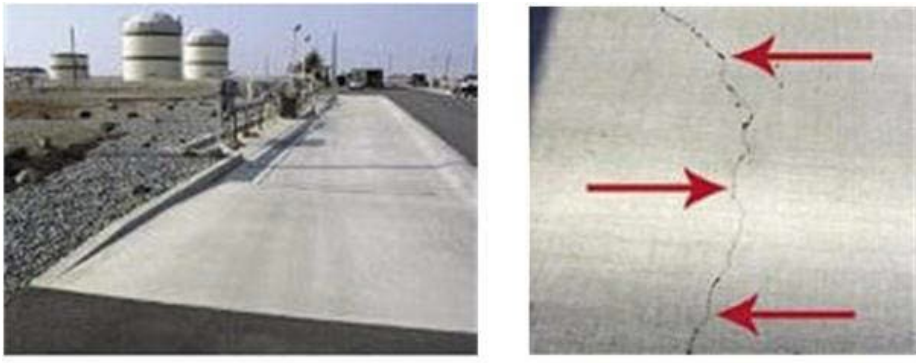
Summary of Findings

Aspects of Concrete Containment Pad Wash Racks

Caltrans facilities traditionally utilize in-ground concrete slab containment pad-based wash rack systems and enclosures. Concrete containment pads are very durable, long lasting, easy to maintain, have virtually unlimited load bearing capability, and are flush with the ground providing unfettered access to vehicles and equipment. These reasons together with no limitations on size or shape explain why concrete pads are the industry standard. The trade-off is that these constructed in-place, permanent concrete pad systems are expensive to install because they are considered permanent structures requiring detailed engineering design and compliance with various federal, state, and local mandates; require Professional Engineer (PE) stamps and building permits; and often must be addressed in Environmental Impact Reports (EIR) subject to community review. Once all permits and approvals are obtained, a formal contractor's bid process follows. There is no standardized design or permit which can be used statewide, so this process must be repeated for each HMS wash rack. In-ground concrete slabs also require substantial site preparation, compaction, a vapor barrier, and layers of various aggregates to reduce the potential of uneven settling of the sub-base over time, as this can cause bending stresses that crack the slab (Figure 1). Containment pad cracking compromises containment, and may result in unseen effluents leaching into the ground beneath the slab.

The resulting pad is difficult to modify for upgraded environmental treatment equipment. In addition, concrete pads are subject to common limitations:

- Concrete, by its very nature, develops cracks.
- Concrete requires expansion joints that allow fluids to seep downward.
- Concrete is porous and absorbs fuels and oils.
- Concrete decays over time.
- Concrete is inflexible and cannot be moved once poured.



80' Lg x 14' W Concrete Containment Pad Costing over $80,000

Lateral cracks develop in this same pad compromising containment

Figure 1. Concrete Containment Pad Failure[2]

[2] http://www.polystarcontainment.com/concrete-vs-containment-pads/

Aspects of Aboveground Modular Wash Racks

Aboveground (also called above-ground) modular wash racks have many advantages over traditional in-ground concrete containment pad-based wash rack systems. Prefabricated wash racks must satisfy the same waste water compliance guidelines in operation as in-ground wash racks. However, prefabricated wash racks have the additional benefit of being classified as equipment and therefore do not necessarily require an architectural design, permitting, or construction approval of any kind. Modular systems can be prefabricated and assembled on-site on any flat hard surface in a matter of hours. These surfaces can be paved or unimproved surfaces. Potential modular wash rack advantages include:

- They are constructed using commercial off-the-shelf equipment.
- Bolt-together systems can be installed in hours.
- They are classified as equipment, so building permits may not be necessary.
- They can be engineered to meet specific needs, such as solvent recirculation systems for asphalt/bituminous road oil equipment cleaning.
- They are compatible with a wide array of customizable open and closed system effluent treatment modules which can be easily attached.
- Non-skid surfaces reduce slips and falls.
- Better control over containment and shelter from storm water incursion.
- Aboveground design provides a defensible gap between catch pad and ground for leakage monitoring.
- They are designed to withstand tire loads up to 15,000 lb and overall load up to 90 tons.
- They have a modular design for maximum layout flexibility, mobility, configurability, and expandability.

The benefits of prefabricated modular wash racks also come with some negative trade-offs in comparison to the traditional in-ground systems. First, prefabricated wash racks are not permanent in nature since they are constructed of sheet metal which is susceptible to structural damage and rusting, especially when used in high-salt environments. In addition, aboveground containment pads require transition ramps which limit access. Finally, since these systems are modular and are built by combining standard-sized components, there are some size and shape limitations.

Aboveground Modular Wash Rack System Description

Prefabricated, aboveground wash rack systems are comprised of three major elements, each of which serve very different functions. The first is the washing system, which can be as simple as a hose bib or could consist of multiple heated, high-pressure spray wands and spray bars. The second is the containment system consisting of a modular containment pad configured in any shape or size with side walls, mud trough, solids conveyor, and cover options. The third is the effluent management system, which can range from a basic suspended solids settling basin to a closed-loop recycling system.

There are many options and add-ons available for both washing and containing systems, but the modular nature of prefabricated wash rack systems compels manufacturers to offer a wide array of options that can be configured into semi-custom solutions. This means that the manufacturers configure a system based on customer need, utilizing the available modular

components and then develop a system price quote. Modular systems can be connected together to accommodate any size vehicle or equipment.

Washing Equipment Options

Pressurized water wands are a desirable upgrade from the basic hose bib and nominal municipal water pressure. Manufacturers offer a multitude of pump-driven washing system options designed to interface with prefabricated wash rack systems. High-pressure water blasters are available and are powered by either electric motors, pneumatic motors, or gasoline or diesel engines. Hot water heater systems can be fueled by electricity, diesel, liquid propane (LP), or natural gas.

Standard high-pressure and low water volume pump systems with pressure washer wands are the workhorse of vehicle and equipment washing operations. These systems typically operate at pressures up to 5,000 pounds per square inch (PSI) with water flows up to 3 gallons per minute (GPM). These low-flow pressure washers are compatible with various heated water systems, spring-loaded hose reels, and soap injection options. High-flow water cannon systems are also an available modular option; these are ideal for heavy equipment de-mucking, snow removal equipment rinse-down, or any application requiring high-volume, low-pressure flow. Water cannon pump equipment can be specified with flows up to 60 GPM and pressures up to 200 PSI.

High Pressure Water Blaster Water Cannon

Figure 2. Pressure Washer Options

Manufacturers offer many spray bar options which are typically connected to a separate pressure washer pump system. The pad design is such that there is room to incorporate underdeck spray bars and nozzle assemblies in almost any pattern or density to meet conventional undercarriage and wheel washing requirements. Side spray bars can be set in pre-wash sections to begin the soaking process as the vehicle enters the wash rack (Figure 3).

Undercarriage/ Wheel Wash Spray Bars

Pre-Wash Spray Bars on Pre-Wash Section

Figure 3. Spray Bars and Pre-wash Sections

Containment Pads

Prefabricated containment pads are comprised of modular sections of various sizes which can be combined to form a pad of almost any size and shape. The steel sections can be placed on any hard, flat surface and bolted together with gasket interfaces to ensure that pad assembly is both watertight and to enable effluent flow through ports between the sections. Pad designs are available with various gutter configurations and mud troughs. These troughs can be cleaned out with shovels or powered drag conveyors to remove heavy mud and solids from the gutter(s), which can then be dumped in dewatering collection bins. A drive-in loader bucket clean-out tray is a popular option for heavy earth-moving equipment operations. Standard options include a wide range of pad axle-weight ratings up to 75 tons. Pre-wash containment pad sections can be added, often fitted with drive-through, pre-wet spray bars. Containment pads are mostly constructed of carbon steel, either powder-coated or galvanized to inhibit rusting; however, the deck is often comprised of pickled and oiled steels, since it is in direct contact with vehicle traffic. Containment pads are generally low-profile but still require drive-on ramps available in various widths and lengths to obtain the customer's desired approach angle. High-lift containment pads and ramps are also available to support undercarriage washing access.

Figure 4. Basic Aboveground Modular Containment Pad (EST Co.)

Effluent Management Equipment

Wash rack manufacturers offer a range of modular effluent management systems designed to connect with their containment pads products. Depending on customer needs, along with application and environmental compliance requirements, manufacturers combine modular components into an engineered custom solution package. Applications include:

- Focus on heavy solids dewatering with powered mud conveyors.
- Winter operations focusing on salt and sand recovery.
- Heavy equipment service operations focusing on oil filtering and degreasing.
- Asphalt equipment cleaning with solvent recirculation systems.
- Heavy fleet drive-through wash racks combined with semi-automated pre-wash systems.
- Water conservation and environmentally-friendly recycling systems.
- Energy-efficient, solar-powered wash systems.
- Compatibility with a wide range of pre-washes, wash soaps, degreasers, and foams.

Treatment systems can be based on open-loop treatment for draining into a sewer, a closed-loop effluent filtering system for recycling, or some combination thereof. There are two types of recycling systems: 100% closed-loop recycling and partial recycling.[3]

100% closed-loop recycle systems

One hundred percent closed-loop recycling systems recycle both wash water and rinse water with no discharge of wastewater to a POTW. These systems require somewhat significant up-front capital costs for engineering, purchasing, and installation of equipment. However, water conservation, along with the additional cost savings associated with reduced water bills and sewer fees tend to make 100% closed-loop recycle systems cost-effective. Water conservation is achieved by piping the wash water through a purification system for reuse. Therefore, there is no need to purify the wash water to a level to meet drinking water or surface water quality standards.

Water quality will degrade over time as the same system water is filtered and recycled over and over again. Bacteria, pathogens, and microorganisms form in recycled water, which can lead to foul odors and the potential for biohazards in the water. Bacterial contamination can be controlled by treating the recycled water with chemicals like chlorine, ozone, etc. or biologically with hydro-biodigester products.[4] Another strategy is to mix fresh water with the recycled water or to have a fresh water post-wash spray system to rinse the recycled water off the vehicle after it has been cleaned. Eventually the wash water will reach a certain level of contamination and need to be properly disposed of. In winter operations, where salt tends to build-up in the recycled wash water, there is an option to dispose of recycled water when the salinity level becomes too high by adding it to brine tank systems used to de-ice roads, again enhancing cost-effectiveness.

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[3] Guide to Best Management Practices- 100% Closed-Loop Recycling Systems at Vehicle and Other Equipment Wash Facilities, Florida Department of Environmental Protection – Industrial Waste Water Section and Pollution Prevention Program, 2005

[4] https://www.hydroblaster.com/files/literature/WaterSafety.pdf

Partial Recycle System

A partial recycling system is a system where wash water is separated from rinse water. The wash water is recycled and the excess rinse water may be disposed of to an absorption field system designed and installed in accordance with local requirements. Partial recycling systems can further be divided into limited recycling and multi-stage filtration systems.

Limited recycling typically provides minimal filtration of water, offering approximately 50 to 80% wash water reuse depending on the technologies used. These systems are designed to remove heavy solids and provide recycled wash-quality water for reuse.

Multi-stage filtration systems can provide 80 to 95% water reuse by incorporating the use of several water treatment technologies. The first stage of filtering settles out suspended heavy solids and separates oils from the wash water. The majority of the filtration takes place in the second stage, which typically incorporates aeration, filtration, and chlorination to ensure the removal of dirt and oils to eliminate odors and organic buildup. The final stage consists of several methods which filter, polish, and re-pressurize the water just prior to feeding the wash equipment.

Freestanding Basic Oil/Water Separator Unit

Closed-Loop Module for the Recycling of Moderate Solids & Oils

Figure 5. Samples of Available Waste Water Filtering Options

Caltrans HMS Wash Rack Overview

Wash racks and their associated wash water treatment systems are an essential element of Caltrans HMS facility operations. For the most part, Caltrans has had to internally custom engineer these systems to satisfy a host of specific applications and locale-associated constraints. Navigating ever-changing environmental requirements and the permits and review process, and obtaining the necessary authorizations can be difficult. For example, in one case, it took 10 years and cost Caltrans 10 million dollars for a system's design, permitting, and construction. Typically these systems consist of in-ground concrete containment pads with a sump well or a sediment dewatering basin. Then Caltrans typically utilizes a low-tech and easy-to-maintain process for wastewater cleaning to ensure Wash Water Waste (WWW) quality is suitable for a variety of alternative dispersal systems or recycling. The constituents of primary concern are toxic compounds, metals, hydrocarbons, salts, and chemicals often found in vehicle maintenance and washing effluents. A diagram (from District 10) of basic Caltrans wash water treatment equipment for removal of dissolved constituents is presented in Figure 6. Caltrans has installed a more complex wastewater recycling systems in District 3 at the Peddler Hill HMS in their greener environment program:

Caltrans News Flash #66 – New Wash Racks Help Caltrans Recycle Water Year-Round
http://www.dot.ca.gov/paffairs/pr/2016/prs/16pr010.html

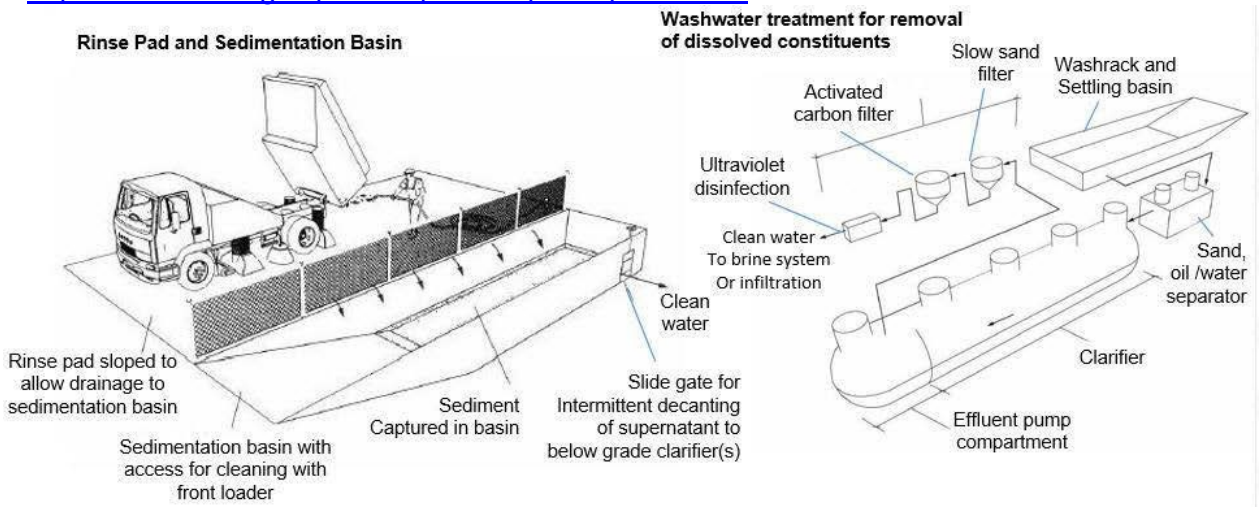


Figure 6. Common Caltrans WWW Management System[5]

Commercial Sources of Prefabricated Wash Rack Systems

The following is a list of major companies that manufacture and/or distribute heavy vehicle wash rack systems. These companies are capable of providing a custom-designed turnkey wash rack system according customer specifications. Companies which supply only specific equipment components utilized in wash rack assemblies are not included here.

Riveer, Inc., Engineered Wash Water Recovery Systems

The Riveer Corporation is one of two major manufacturers of modular wash rack equipment in the United States. They distribute the Mudmaster line of prefabricated, aboveground steel wash rack systems and associated effluents and solids management equipment. According to the company website, Riveer racks are modular for bolt-together installation and feature the lowest profile in the industry for easy access of low-clearance sweepers, plow trucks, and mowers. Riveer racks are safer for equipment and employees, with diamond tread grit impregnated epoxy paint surfaces for excellent traction even when wet and soapy. Systems can be configured and customized according to customers-specific needs. The main variables are the size and shape of the containment pad, water blasting equipment capabilities, and containment walls and covers. Effluent filtering and/or recycling technologies can be engineered to meet specific BMP requirements.

Prefabricated, Aboveground Steel Wash Racks:

http://riveer.com/steel-wash-racks/

[5] Startup, Operation and Maintenance Manual for Wash Water Treatment and Reuse Systems, H. Leverenz, A. Holmes, Caltrans District 10 Storm Water Program, 2013

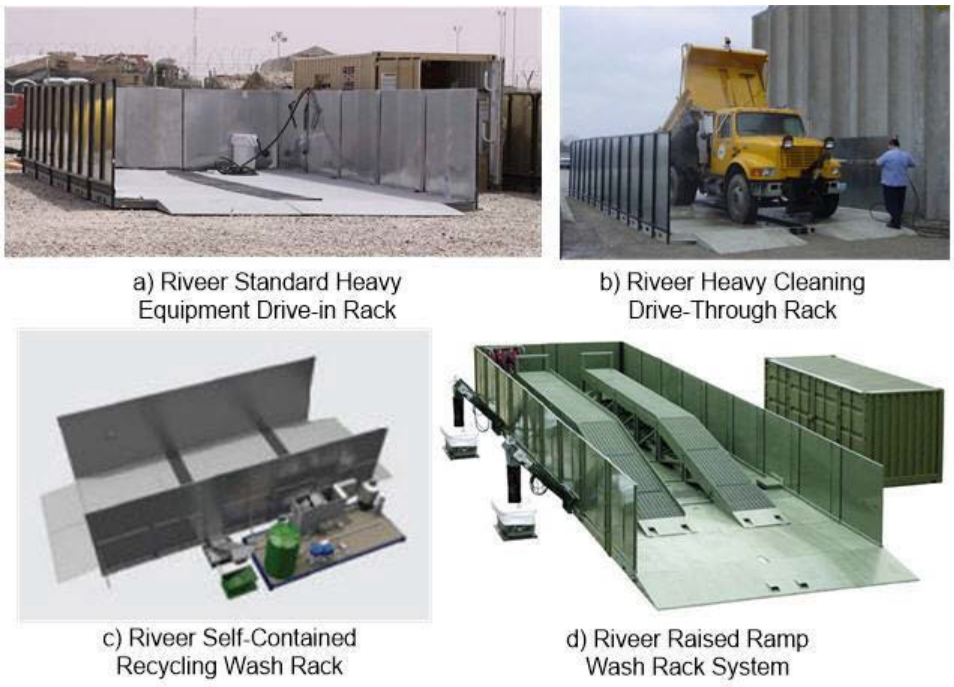


Figure 7. The Riveer Rack in Various Configurations

EST Companies – Wash Systems, Equipment, and Service

According to the company website, EST Co. is in the business of solutions that partner with companies to include sales, training, support, and service. EST Co. designs custom vehicle wash facilities according to customer specifications utilizing commercially available equipment; performs on-site equipment installation; and provides in-the-field training, service, and maintenance.

Prefabricated, Aboveground Wash Racks:

http://envirosafetytechnologies.com/above-ground-wash-rack.html

Figure 8. EST Co. Wash Rack System Shown with Mud Conveyor, Pressure Washer Wands, and Filter System

HE Hydro Engineering, Inc.

Hydro Engineering, Inc., (HE) is the other major manufacturer of wash rack systems in the United States. According to the company website, Hydro Engineering's Hydropad portable wash rack system allows you to quickly deploy a complete Wash/Collect/Recycle or Pre-Treatment system in a fraction of the time it takes to construct a wash rack. Their modular systems can

accommodate any size equipment you need for washing. The systems are engineered to capture water and channel effluent into the gutter systems of the Hydropad. Captured effluent can then be diverted to a Hydrokleen water filtration system and sent back out to the Hydroblaster washing system for 100% water efficiency.

Prefabricated, Aboveground Wash Racks:

https://www.hydroblaster.com/About.htm

HE Hydropad Wash Rack System

Drive-in Clean-out Tray

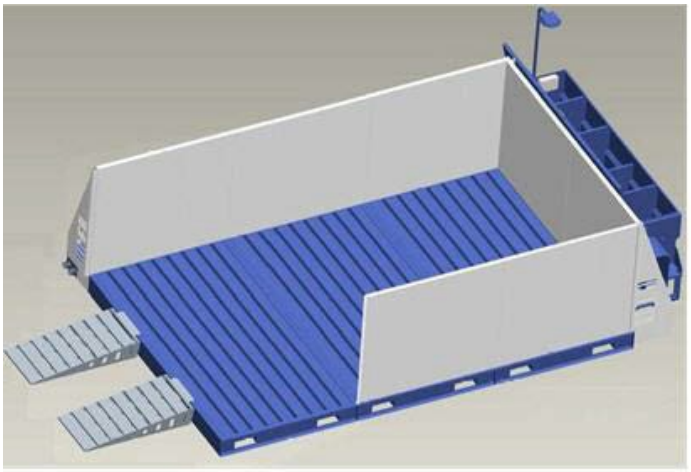
Figure 9. HE Hydropad

Generac Mobile Products

Generac manufactures prefabricated wash rack systems comprised of a standard selection of modular components. These components can be assembled in many different configurations to satisfy customer needs and custom modules can be engineered by the company.

Modular Aboveground Wash Racks:

http://www.towerlight.com/international/En/washing-bay-modular-wash-rack.php



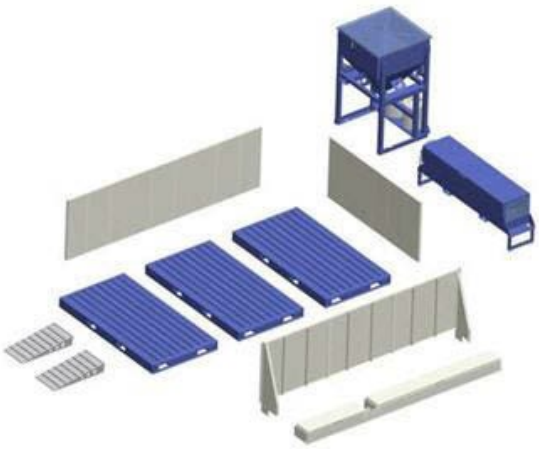


Figure 10. Generac Wash Rack

Washbay Solutions International

According to their website, Washbay Solutions International has specialized in high-tech, custom-engineered solutions to complex washing and wastewater issues since 1991. Prefabricated, aboveground wash racks are one of the many products and services offered by the company.

Prefabricated Wash Rack Solutions:

http://www.washbaysolutions.com/portable-wash-bay-containment-pads.php

Figure 11. Washbay Solutions Int. Prefabricated Wash Rack Systems Showing Modular Heavy Equipment Wash Pad Configurations

Prefabricated Wash Rack Covers and Housing Structures

Some strategy should be employed to mitigate storm water intrusion into the wash rack which can end up overflowing the system. Often wash racks are sheltered from storm water by a cover, roof, in-line valve conversion, or containment building. Some prefabricated wash rack systems offer containment pad tarp covers which can be rolled out during rain events. There are also canopies of various sizes available for better convenience in warm climates where snow loading is not an issue. Simple covered systems like these often house any associated treatment equipment in a metal shipping container-type enclosure placed adjacent to the containment pad (for example Figure 8). Prefabricated wash rack systems intended for use in areas with potential snow loads often utilize tensioned fabric buildings to house the entire wash rack system. These high-performance, rust-free aluminum fabric structures can typically be delivered in three weeks, installed in one to three months, and do not require concrete foundations. The performance of these buildings is consistent with the moveable equipment classification of the prefabricated wash system.

Sprung Company – High Performance Tensioned Membrane Structures

http://www.sprung.com/

Fabric Structures – USA LLC.

http://www.fabricstructures-usa.com/

Nevada DOT Prefabricated Wash Rack Sprung Structure

Wash Rack and Treatment System Housed in a Traditional Steel Building

Figure 12. Wash Rack Housed in Tensioned Fabric Building & Traditional Steel Building

A storm water diversion valve is another way to prevent storm water from overflowing the system if a wash rack cannot be covered with a roof. This allows the system to discharge uncontaminated storm water runoff from the wash pad to an appropriate storm water drain when the pad is not in use.

Caltrans South Lake Tahoe EST Co. Prefabricated Wash Rack System

The Lake Tahoe Basin has some of the most stringent water quality restrictions in the country. One of the ways Caltrans District 3 is working to reduce their environmental impact in the sensitive Lake Tahoe region is by establishing a greener fleet vehicle washing program and facility at the South Lake Tahoe HMS. This effort was delayed for years due to a host of compliance, budget, and time constraints. Determined to make near-term environmental improvements, District 3 took the initiative of establishing a pilot program to acquire and operate a commercially available, prefabricated wash rack system to be housed in a prefabricated building in South Lake Tahoe. Since both the wash rack system and building are relocatable, aboveground equipment, this acquisition does not preclude Caltrans from concurrently pursuing the approval to install a conventional in-ground wash rack system. If a permanent wash rack system is approved and funded for this location, the prefabricated wash rack system can be easily moved to another HMS facility or removed and sold.

The complete turnkey commercial wash rack system Caltrans District 3 purchased[6] has a 56 ft x 20 ft modular aboveground wash rack containment pad with two integrated mud drag conveyors, all from EST Co. The wash rack will be contained in a 75 ft x 40 ft Sprung building in the South Lake Tahoe HMS. The associated effluent treatment system purchased is a closed-loop Riveer RTS5000 recovery system with pressure washers, water cannon, and undercarriage/wheel wash spray bar. The containment pad will be configured as a drive through with ramps on both ends and 8-ft-high galvanized steel containment side walls. EST Co. has designed this wash rack system specifically for the higher salt environment of Caltrans winter operations, and projects a 15 to 20-year average service life. Utilities will be run underground to the site, which will be otherwise unimproved, with the building and wash rack system placed on flat compacted level gravel and soil. The cost of the complete wash rack system and containment building installed is under a million dollars, and the entire design and procurement process took less than four years.

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[6] Caltrans WO: 13152, Contract #: 19303, Riveer RTS5000, Pressure Washer, Water Cannon Manual, Caltrans District 3, South Lake Tahoe, User manual, 2016

The South Lake Tahoe site where this prefabricated wash rack will be initially operated is especially sensitive to salinity concentrations. Therefore, the recycling system specified by Caltrans District 3 includes a salinity sensor in the closed-loop filtration system to monitor salinity levels and redirect water exceeding compliance levels into a recycling tank. Depending on the amount of high-salinity wash water generated, the wastewater can be diluted for proper disposal or added to brine tanks after being properly tested for the presence of other pollutants. Fresh water will constantly be added to the recycled wash water to account for evaporation and various other common causes of water loss. The fresh water addition will help moderate salinity levels, but ultimately only by testing the system during a normal course of winter operations will the exact method of salinity control be established.

One of the most common criticisms of prefabricated wash rack systems, especially systems with sophisticated closed-loop filtration systems, is their patently complex system operations and maintenance procedures. To ensure the South Lake Tahoe closed-loop wash rack operates at optimum efficiency, Caltrans District 3 purchased an additional multi-year manufacturer training, maintenance, and service contract. Manufacturer training on the system will be provided multiple times a year. The manufacturer will provide a contact number where the manufacturer can be contacted to provide urgent instruction and service to help mitigate seasonal changes in the Caltrans workforce.

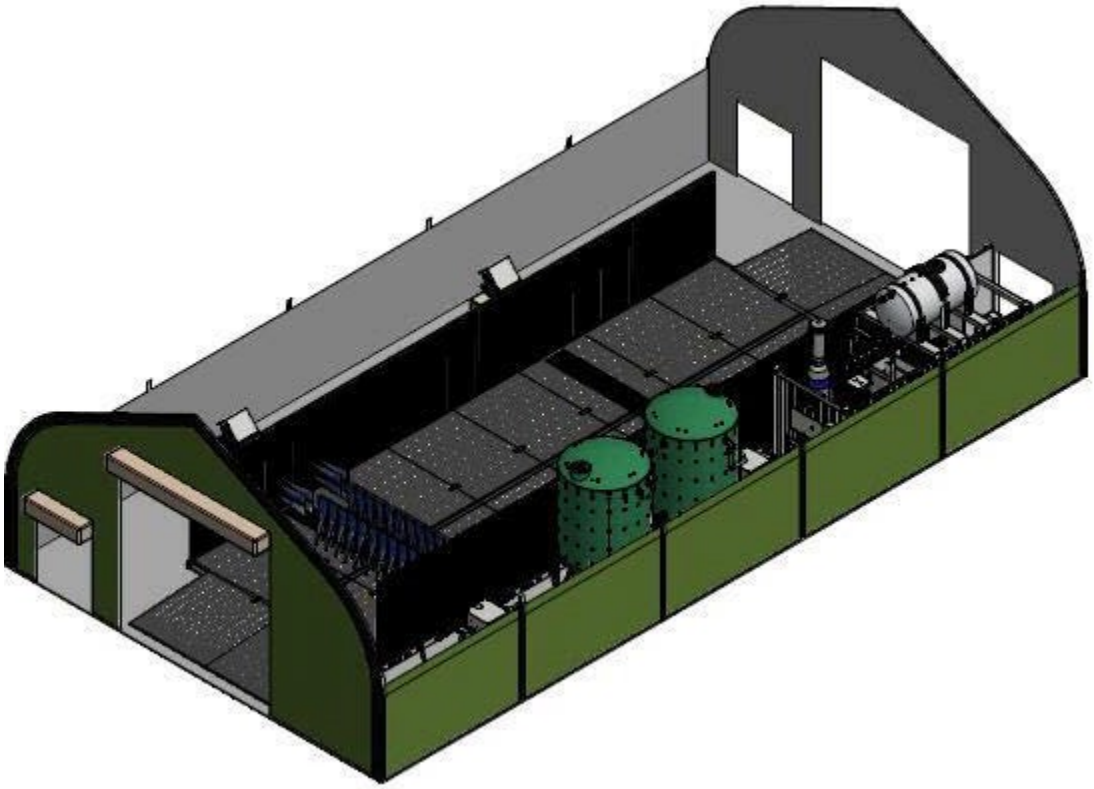

Figure 13. Caltrans District 3 EST Co. Prefabricated Wash Rack System

Related Research and Resources

A comprehensive literature search was performed utilizing Google, Google Scholar, and the Transportation Research Board (TRB), American Society of Civil Engineers (ASCE), and Federal Highway Administration (FHWA) web search tools. This search produced one military-sponsored study directly related to prefabricated, aboveground wash racks. It describes a

prototype, self-contained vehicle washing system developed for the U.S. Army.[7] Several additional research studies were identified which focus on innovative methods of filtering wash water for discharge or recycling.

The first report, an evaluation of two prefabricated wash rack recycle treatment systems, was written by the Army Corps of Engineers,[8] and the second report documents strategies to mitigate salt runoff, describing the method of disposal of recycled wash water with high salinity levels by adding it to brine tanks[9]. Overall, the military has different goals from Caltrans for their application, which may make their input less useful. The military's goals are focused on mobile operations, on more rudimentary cleaning, and seem less focused on environmental concerns. The California Storm Water BMP Handbook[10] (NS-8-Vehicle and Equipment Cleaning) describes the functional requirements that should be followed. These are consistent with the Caltrans Division of Equipment regulations that address vehicle washing.

Gaps in Findings

One of the key benefits to utilizing prefabricated wash rack systems is that these systems are considered equipment and therefore permits from local, state, and federal water quality agencies may not be required. The extent to which this is true is contingent on how the system is configured. Since these systems are portable in nature, it seems likely that building restrictions and permitting would be minimal. Any regional wastewater disposal restrictions would still apply independent of the containment system specifics. However, these restrictions can be minimized by utilizing a recycled filtration system and transporting any generated waste water off-site for treatment. Since the system configuration specifics greatly influence the exposure to location-specific permits, inspections, and reporting, further investigation would be necessary to determine Caltrans-specific requirements and the expected benefits.

Modular wash rack systems can be fabricated out of a variety of steels and coatings. The higher the corrosion resistance, typically the higher the associated cost, which greatly affects the overall system price. It is important to determine the expected service life of these systems as it relates to these different materials to determine which will best meet Caltrans' needs, especially in high-salt winter environments.

Next Steps

Caltrans Prefabricated Wash Rack Evaluation

The performance of the Caltrans District 3 prefabricated, aboveground wash rack being installed in South Lake Tahoe affords the opportunity of developing a field trial evaluation study of this equipment. A deployment study could be used to determine the useful specifications, operational efficiency, and environmental improvements in field operation of modular

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[7] Final Report: Self-Contained Automated Vehicle Washing System, U.S. Army Research Office, Octaflex Environmental Services Inc., R. Gross P.I., B. Gross Adm.

[8] Evaluation of Two Wash Rack Recycle Treatment Systems, G. Gerdes, K Hudson, P. Stemniski, E. Engbert, U.S. Army Corps of Engineers, USACERL Technical Report 98,1998

[9] Strategies to Mitigate Salt Runoff from Salt Storage and Salt Truck Maintenance Facilities, J. Meegoda, T. Marhaba, P. Ratnaweera, ASCE, 2004

[10] California Storm Water BMP Handbook, New Development and Redevelopment, Vehicle Washing Areas SD-33, 2003

prefabricated wash rack systems versus conventional, engineered, in-ground concrete wash rack systems.

Detailed Findings

Consultation with State DOTs

This section presents the results of a survey of other transportation agencies' current practices or experiences with commercially available, prefabricated, aboveground wash rack systems in their highway maintenance station facilities. This survey was sent by the Caltrans Division of Research, Innovation and System Information (DRISI) to the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee (RAC) for distribution. Of the 50 states and other transportation agencies contacted, the below questionnaire responses were received. The questionnaire is provided here for reference and the questions are omitted in the results section.

1) Does your agency utilize commercially available, aboveground, prefabricated vehicle and equipment wash rack systems in your facilities or worksites? If so, please describe the make and model of the systems used.
2) Does your agency purchase the modular containment pads separately, or as complete wash rack systems from the manufacturer including an associated modular filtering system(s)? If so, please describe the type and make of the treatment systems used.
3) Does your agency also utilize more advanced optional features on these wash rack systems such as: integrated overspray walls, mud conveyor, covers, heated water, pressurized water blast, and/or fixed in-place spray bars? If so, please identify which.
4) What is your agency's average cost of the procurement and installation of your commercially available, prefabricated, aboveground wash rack systems?
5) What factors does your agency consider when deciding whether to design a custom wash rack or procure a commercially available wash rack system? To what degree are environmental requirements/permitting a deciding factor in this process?
6) If you feel your agency has more information to offer on this subject, please provide contact information to allow a follow-up discussion.
7) Please provide any other information or feedback that you believe may be of value for this research.

Florida DOT

J. Darryll Dockstater, Manager, Research Center

Response: FDOT does not have above-ground, prefabricated vehicle and equipment wash rack systems in our maintenance facilities. We use commercial vehicle wash vendors if available for passenger vehicles.

Illinois DOT

Timothy Armbreccht, P.E., S.E., Engineer of Maintenance Operations

Response: We don't have anything like this, but I'd sure be curious to see what other states are doing. We just finished Architecture/Engineering selection for a project we having coming up to build a drive through truck wash designed for our trucks. The system should be able to

thoroughly wash the truck, undercarriage, and bed. We need to be able to drive through the truck wash with the plow on.

Kansas DOT

W. Clay Adams, Bureau Chief of Maintenance

Response: We build enclosed wash bays with a mud pit and grease and oil separator but do not have any kind of a wash rack in it.

Mississippi DOT

Respondent: Robbie Vance, Research Liaison

Survey answers: Our agency doesn't use these wash racks.

New Jersey DOT

Camille Crichton-Summers, Manager, Research Bureau

Response by Jim Schmidt NJDOT: We are in the early stages of looking at the same equipment. We recently went to a demo in Lakewood with a company call MilSpray http://www.milspray.com/products-services/vehicle-wash-systems We and the vendor had concerns with using this type of system in below freezing temperatures since metal wash rack will ice over and become a slip and fall hazard. While I cannot offer California any real life information on their questionnaire I would love to see the results once they are compiled.

Follow up: Milspray Company is a distributer clearly focused on military applications.

New Mexico DOT

Ryan Metzger, Equipment Manager, District 6

Response: Regarding the questionnaire for the wash rack, District 6 NMDOT does not have one. We were looking into one about 10 years ago and came to the conclusion that it was not cost effective at that time.

Vermont Agency of Transportation (VTrans)

Dr. Emily Parkany, P.E., Research Manager

Response by Ken Valentine: VTrans does not (to my knowledge) use any such racks.

West Virginia DOT

Jeff Pifer, P.E., Operations Section Leader

Response: Not aware of any prefabricated wash racks at DOH facilities.

Wisconsin DOT

Respondent: Diane Gurtner, Research & Library Services

Survey answers: WisDOT does not own any maintenance equipment. We hire the counties to perform the maintenance work and each county is unique.

Wyoming DOT

Respondent: Brian Wenger, Assistant Equipment Manager

Survey answers:

1. The Wyoming D.O.T. only has one unit and it is located in our Cheyenne location. The unit we have is a Mark VII unit that has been in place for over 11 years.
2. Our system was purchased through Mark VII and they installed it in our vehicle storage building along with their pump and filtration system.
3. Our car wash is over 11 years old and the only optional feature is the under body spray bar.
4. When the unit was installed the cost for the unit and installation was $114,317.00.
5. Our factors included finding a unit that would fit into the space available and cost. We tried to find a unit that used the least amount of water but no permitting was necessary when the system was installed.
6. No response
7. No response

Follow up: The WashTec/Mark VII Companies main product line appears to be focused on the consumer automated car wash market. http://www.markvii.net/

Consultation with Non-DOTs

County of Sacramento

Respondent: Dan Miller, Fleet Manager

Survey answers:

1. No, the county of Sacramento has two vehicle and equipment wash facilities in permanent structures.
2. Not Applicable
3. Not Applicable
4. Not Applicable
5. The decision to build a fixed facility custom wash rack was based on the volume and types of vehicles using the facility as well as life cycle cost of the facility, environmental concerns and permitting processes. The facility at our Branch Center location was

constructed well before the prefabricated, portable above ground systems evolved in the Fleet industry.

6. Please contact me at email or telephone number above if we can be of assistance.

Global Environmental Products

Respondent: Jim Donnan, Technical Support

Survey answers:

1. Yes.
2. Purchase completed
3. Overspray walls, high pressure, water blast
4. Approx. $78K
5. It was a turn-key operation, self-contained and water was recycled no discharge from property.
6. (909) 713-1614
7. After one year we signed up for a maintenance program costing $400-500/quarter

Louisiana Transportation Research Center

Respondent: Tyson Rupnow, Ph.D., P.E., Associate Director, Research

Survey answers:

1. *District 04:* We have 1 that has not been effectively used largely due to the complexity of the system. *HydroBlaster 7000* by Hydro Engineering.

   District 05: We have 1. Please see the attached construction proposal for the unit installed.

2. *District 04:* We bought, by construction contract, the system as one piece of equipment.

   District 05: No modular containment pads. Please see the attached construction proposal for the unit installed.

3. *District 04:* Pressurized, propane heated, hot water, oil separator unit

   District 05: None

4. *District 04:* $103,000

   District 05: One time cost of about $103,000

5. *District 04:* Not known

   District 05: Not known

   District 08: Recently evaluated this but has instead elected a custom wash rack offered the following response: Our decision to go with a custom designed wash rack with based on:

- Initial Capital Costs
- O&M Costs
- O&M Issues and Problems – District 05 has one and it does not perform well for them

6. *District 04:* Long lead time, pre pay required, Warranty expired shortly before or shortly after receipt of unit.
7. *District 04:* System could be very much improved by making it less sophisticated. I would not purchase this system again unless major changes to the entire experience was completely modified. Very dissatisfied with it.

Sacramento Municipal Utility District (SMUD)

Steven Fratis, Fleet Asset Manager, SMUD Corporation yard

No Response

Sunbelt Rentals

Respondent: David M. Kolker, Construction Manager

Survey answers:

1. Yes we do, we use a Riveer Recycling System RST 3000 and RST 500.
2. Complete wash rack system, we use a Riveer Recycling System RST 3000 and RST 500
3. Integrated overspray walls, pressurized water blast, Cone-Bottom Tank (2500 Gal) w/w/spin-down separator
4. $68,000 to $95,000
5. All of our stores have completely different requirements depending on the size of the fleet and the kind of fleet at each location. Riveer has the ability to design the system that meets our requirements for each location.

Contacts

AHMCT and Caltrans DRISI contacted the following individuals to gather information for this investigation.

Agencies

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